Name: _____ Date: _____ Period: _____

Must-Knows: Unit 5 (Cell Structure and Transport)

Ms. OK, AP Biology, 2014-2015

Test Format: 25 multiple choice questions, 5 calculation questions, 1 short response question

Topic #1: Cell Structure and Function

1. Identify the differences between a prokaryotic and a eukaryotic cell. Discuss the structures found in these cells, their relative size, and the types of organisms in which these cells are found.

Prokaryotic Cell = has no membrane-bound organelles (ex: ER, Golgi, mitochondrion), does not have a nucleus to hold its DNA, is smaller than a eukaryotic cell, is found in archaea and bacteria

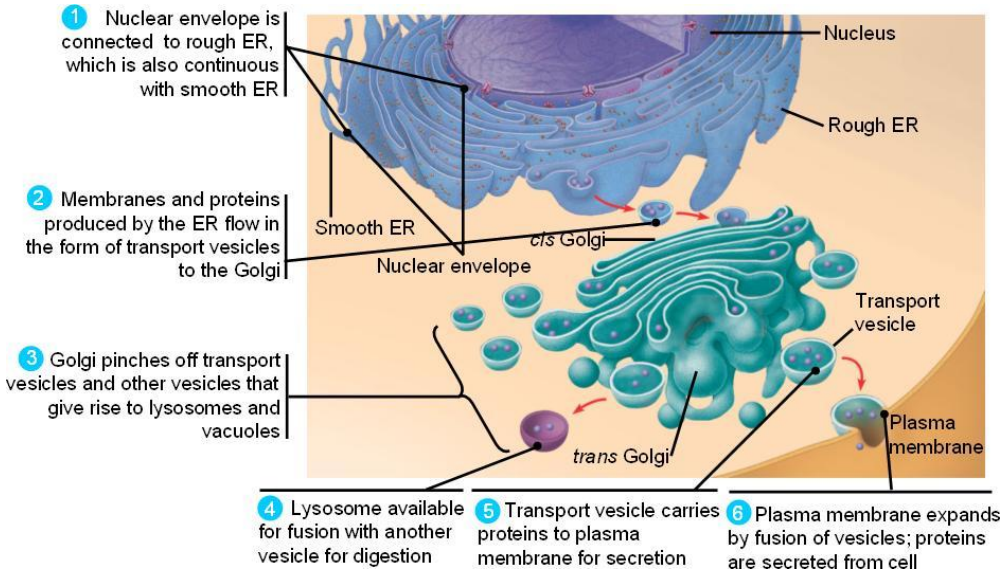
Eukaryotic Cell = has membrane-bound organelles, has a nucleus to hold its DNA, is larger than a prokaryotic cell, is found in protists, fungi, plants, and animals

2. Why is it an advantage for eukaryotic cells to have different compartments (aka organelles) in the cell (separated by membranes) with different environments (ex: different pH's, different enzymes present, etc)?

This allows eukaryotic cells to isolate a particular process or reaction (ex: cellular respiration) in a part of the cell (ex: mitochondrion) that has the ideal chemical environment for that process.

3. Discuss the pathway that secretory proteins (proteins destined to leave the cell) take through the endomembrane system starting with their synthesis and ending with their secretion from the cell.

-Ribosomes on the nuclear envelope or rough ER create proteins. These proteins enter the ER inner space (called the lumen) and may be modified by enzymes in this inner space. For example, certain proteins receive carbohydrate chains to become glycoproteins used on the surface of the cell membrane for cell-cell recognition.
-The proteins created and modified travel to the Golgi apparatus via vesicles (small membrane sacs) that bud off of the ER and later fuse with the cis side of the Golgi. (Note: the Cis side of the Golgi is closer to the ER and farther from the cell membrane)
-In the tubes/sacs of the Golgi (the cisternae), proteins are modified by more enzymes that can break off parts of proteins or add additional molecules on. These proteins are then packaged into new vesicles that bud off the trans side of the Golgi and later fuse with the cell membrane to release their contents outside of the cell. (Note: the Trans side of the Golgi is closer to the cell membrane and farther from the ER.)



4. Cells with a large amount of Rough ER might be specialized for which function?

These cells might be used for producing large quantities of protein to be secreted from the cell (ex: protein hormones).

Cells with a large amount of Smooth ER might be specialized for which function?

These cells might be used to create large amounts of lipids or break down toxins. (Ex: Liver cells have a large amount of Smooth ER because they are used to filter toxins from the bloodstream.)

Cells with many lysosomes might be specialized for which function?

These cells might use enzymes to break down molecules, old cell parts, bacteria cells, etc. (For example, macrophage cells in the immune system are used to "swallow" bacteria using endocytosis and break down the bacterial cells using lysosomal enzymes.)

Cells with many vacuoles might be specialized for which function?

These cells might be used for storage. For example, cells in fat (adipose) tissue surrounding internal organs of the human body store large amounts of fat (triglyceride) molecules in vacuoles.

Cells with many mitochondria might be specialized for which function?

These cells might be used for activities with high energy requirements. For example, sperm cells have many mitochondria because they need a lot of energy to swim up the female reproductive tract. Muscle cells also have many mitochondria because they require a lot of energy to contract and cause movement

Cells with many chloroplasts might be specialized for which function?

These cells might be specialized for using photosynthesis to create glucose using the energy in sunlight. Leaf cells in plants have many mitochondria because leaves are the structures on plants that are closest to the sun, so they perform photosynthesis most efficiently.

Cells with cilia and flagella might be specialized for which function?

Cells with cilia and flagella are specialized for movement. Sperm cells have a flagellum that helps them to swim. Cells of the respiratory tract (ex: in the windpipe / trachea) have cilia to "sweep" dust particles out of the body.

Cells with many ribosomes might be specialized for which function?

Just like cells with a large amount of Rough ER, cells with many ribosomes are specialized for creating proteins.

Cells with cell walls but no other organelles (i.e. dead cells, like some found inside the trunks of trees) might be specialized for which function?

These cells might be used for support (ex: cells in fingernails) or for transporting materials. For example, there are tubes within plant stems / tree trunks created using dead cells with pores / holes in the cell wall to allow the movement of water up the stem of the plant from cell to cell. The tube created by these dead cells is called the xylem.

5. In what organelles are microtubule proteins used?

The cytoskeleton, cilia, and flagella.

6. How are plasmodesmata in plant cells and gap junctions in animal cells similar? What are they used for? How are animal cell tight junctions and desmosomes (aka adhesion junctions) different?

Plasmodesmata and gap junctions are both holes/pores that chemically connect cells so they can pass materials between their cytoplasms. Tight junctions and desmosomes are used to physically connect / stick cells together to form a seamless layer (ex: skin cells must connect together physically to form a "sheet" of skin).

7. Are proteins produced in free ribosomes (aka cytoplasmic ribosomes) used in the cell or sent out of the cell?

Ribosomes that are free floating in the cytoplasm are used to create proteins that will be used inside the cell. Examples of these proteins include enzymes used to break down molecules to be used for energy in the cell (ex: glucose).

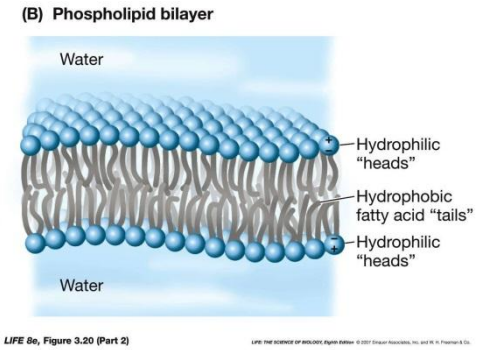
8. Where are proteins produced in bound / attached ribosomes (aka Rough ER ribosomes) used in the cell? What is an example of a protein produced in a bound ribosome?

Ribosomes that are bound / attached to the Rough ER are used to create proteins that will be secreted / exported from the cell via the endomembrane system. Examples of these proteins include protein hormones like Human Growth Hormone.

Topic #2: Cell Membrane and Transport

9. How do phospholipid molecules arrange themselves in the cell membrane? How does this give the cell membrane selective permeability (aka semipermeability)?

Phospholipid molecules arrange themselves in a double layer with the polar / hydrophilic heads facing the water on the outside and inside of the cell. The nonpolar / hydrophobic tails isolate themselves on the inside of the membrane so they do not have to interact with the water on the outside and the inside of the cell.



LIFE 8e, Figure 3.20 (Part 2)

10. List three possible functions of membrane proteins.

Membrane proteins can be used for transport of substances across the membrane (ex: protein channels or carriers for facilitated diffusion or protein pumps for active transport), for cell-cell recognition (these are usually glycoproteins, proteins with carbohydrate chains attached), and for attachment to other cells.

11. What is the function of carbohydrate chains on the outside surface of the cell membrane?

Each cell has a unique pattern of glycolipids (phospholipids with carbohydrate chains attached) and glycoproteins (proteins with carbohydrate chains attached). This particular sequence of glycolipids and glycoproteins identifies the cell and allows it to be recognized by other cells.

12. How would increasing the amount of cholesterol molecules in between the phospholipids in the cell membrane affect the membrane's flexibility?

This will decrease the membrane's flexibility.

13. How would increasing the amount of saturated phospholipid tails in the cell membrane affect the membrane's flexibility? Explain your answer.

This will decrease the membrane's flexibility because the phospholipid tails will be straight, and therefore, the phospholipid molecules would be closer together / packed in more tightly in the phospholipid bilayer.

14. Which cells (smaller or larger cells) have higher surface area to volume ratios? How does this relate to the efficiency of transport across the membrane?

Smaller cells have a higher surface area to volume ratio, indicating that they have more membrane surface area compared to their volume. Cells with more membrane are more efficient at transporting materials into and out of the cell. This is significant because all cells must take in nutrients and send out wastes.

15. Plant cells have a large central vacuole. How does this affect the surface area to volume ratio of the cell? (Hint: See the Unit 5, Part 1 Notes section on vacuoles)

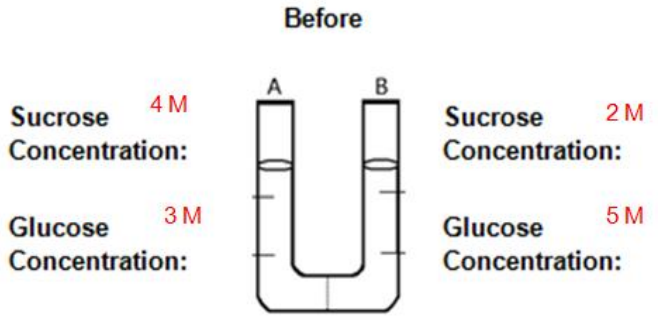
Plant cell vacuoles are so large that they reduce the volume of the actual cytoplasm. (In other words, they take up a lot of the space inside the cell). This makes the surface area to volume ratio larger and improves the efficiency of cell transport.

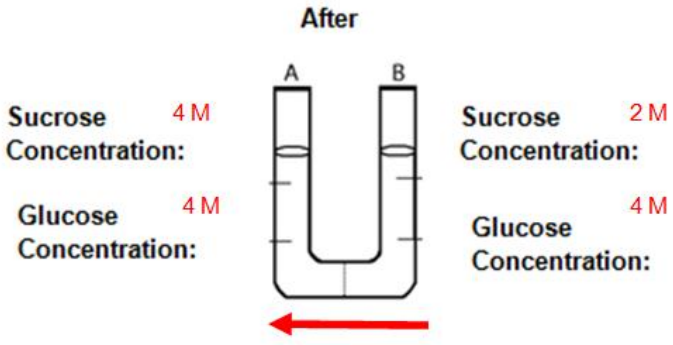
16. The solutions in the two arms of this U-tube are separated by a membrane that is permeable to water and glucose but not to sucrose. Side A is half-filled with a solution of 4 *M* sucrose and 3 *M* glucose. Side B is half-filled with 2 *M* sucrose and 5 *M* glucose. Initially, the liquid levels on both sides are equal.

    After the system reaches equilibrium, what changes are observed in side A? (Circle the correct term that completes the statement)

    - The concentration of sucrose **increases / decreases / stays the same**
    - The concentration of glucose **increases / decreases / stays the same**
    - In response to the movement of solutes, the water level **increases / decreases / stays the same**

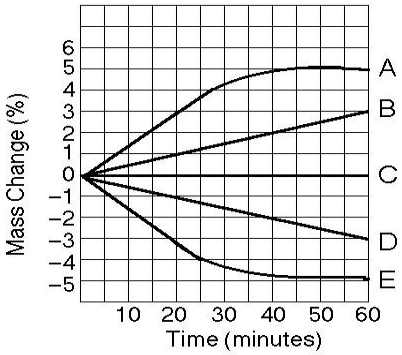
    You may want to draw a sketch (see images below) to indicate solute concentrations in the "U-Tube" before and after movement of solutes across the membrane. You may also want to draw an arrow on your "after" picture to indicate the direction of water movement.





17. Five dialysis bags, constructed from a semipermeable membrane that is impermeable to sucrose, were filled with various concentrations of sucrose and then placed in separate beakers containing an initial concentration of 0.6 *M* sucrose solution. At 10-minute intervals, the bags were massed (weighed) and the percent change in mass of each bag was graphed.

    - A positive percent change in the mass of the bag indicates that water has **entered / left** the bag.
    - A negative percent change in the mass of the bag indicates that water has **entered / left** the bag.
    - Bags A and B contain a solution that is **hypotonic / hypertonic / isotonic** to the outside solution
    - Bag C contains a solution that is **hypotonic / hypertonic / isotonic** to the outside solution.
    - Bags D and E contain a solution that is **hypotonic / hypertonic / isotonic** to the outside solution.
    - Bag **A / E** has the highest initial concentration of sucrose.
    - Bag **A / E** has the lowest initial concentration of sucrose.
    - Bag **A / E** has the highest initial concentration of water.
    - Bag **A / E** has the lowest initial concentration of water.



18. What kind of molecules pass through the cell membrane most easily? (small vs. large, nonpolar vs. polar or charged)

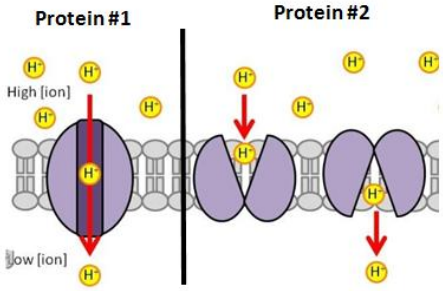
Small, nonpolar molecules pass through the membrane most easily. Because they are small, they can fit through the spaces between the lipids (unlike large particles). Because they are nonpolar, they can pass through the nonpolar tail region of the membrane (unlike polar or charged particles).

19. Complete each statement below with the term that describes the effect of water movement into and out of real plant and animal cells.

    - When placed in hypotonic solution, a plant cell becomes **plasmolyzed / flaccid / turgid.**
    - When placed in isotonic solution, a plant cell becomes **plasmolyzed / flaccid / turgid.**
    - When placed in hypertonic solution, a plant cell becomes **plasmolyzed / flaccid / turgid.**
    - When placed in hypotonic solution, an animal cell may **shrivel / lyse.**
    - When placed in hypertonic solution, an animal cell may **shrivel / lyse.**

20. In the picture given below, identify the carrier protein and the channel protein. What type of membrane transport is shown in this image?

Protein #1 is a channel protein, and protein #2 is a carrier protein. Facilitated diffusion is shown in this image.

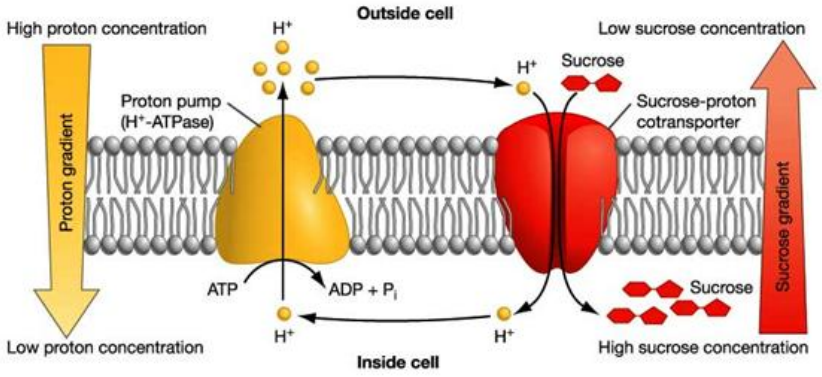


21. If the image above shows the movement of H+ into the cell, what direction will water move (into or out of the cell) and why?

Water will move into the cell to follow the movement of H+.

22. Describe how sucrose is transported into the cell using the H+ / sucrose cotransporter. Use the image below to help you!

The active transport of H+ out of the cell using a proton pump fueled by ATP causes a concentration gradient to form with a high concentration of H+ outside the cell and a low concentration of H+ inside the cell. H+ then "wants" to move down its concentration gradient from the outside to the inside of the cell. It binds to the sucrose-H+ cotransporter. Once sucrose is bound to the cotransporter, the cotransporter changes shape to release both sucrose and H+ on the inside of the cell. The cotransporter does not require ATP to change shape, instead it uses the energy from the H+ concentration gradient established by the proton pump.



23. What is a symporter? How is it different from an antiporter?

A symporter is a cotransporter that moves two substances across the membrane in the SAME direction. One substance moves DOWN its concentration gradient, and this provides the fuel to move the other substance UP its concentration gradient. An antiporter is a cotransporter that moves two substances across the membrane in DIFFERENT directions. One substance moves DOWN its concentration gradient, and this provides the fuel to move the other substance UP its concentration gradient.

24. Is the H+ / sucrose cotransport system involved in passive or active transport? How do you know?

This is a type of active transport, since energy is required to fuel both the proton pump AND the sucrose-H+ cotransporter. The proton pump uses energy released from the hydrolysis (breakdown) of ATP into ADP and P. The sucrose-H+ cotransporter uses energy captured from the H+ concentration gradient established by the proton pump.

25. Describe the difference between the three types of endocytosis—phagocytosis, pinocytosis, and receptor-mediated endocytosis. How is endocytosis different from exocytosis?

Phagocytosis involves the cell taking in large amounts solid particles (cell eating). Pinocytosis involves the cell taking in large amounts of liquid with dissolved solutes (cell drinking). Receptor-mediated endocytosis requires substances to bind specifically to receptor proteins on the surface of the membrane before a vesicle begins to form to take these particular substances into the cell. Receptor-mediated endocytosis is the only type of endocytosis that "chooses" the substances it brings into the cell. Endocytosis takes large amounts of materials INTO the cell, and exocytosis sends large amounts of materials OUT OF the cell.

Topic #3: Water Potential and Cell Size Calculations

****For this section, please review your Water Potential Tutorial and Practice Worksheets 1 and 2, the Calculating the Solute Concentration of a Potato Cell Worksheet, and the Cell Size Calculations Worksheet)****